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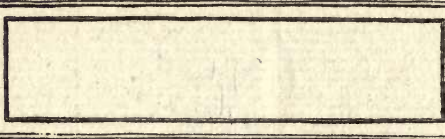
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American Society of Municipal
Improvements, 1915

SPECIFICATIONS FOR

Sheet Asphalt Paving

ADOPTED OCTOBER 14, 1915

These specifications will be modified from time to time to keep them fully up to date. Suggestions as to modifications or additions are solicited and should be sent to the Secretary, or to Francis P. Smith, 131-3 East 23d St., New York City, Chairman of the Sub-Committee on Specifications for Asphalt Paving, and —

GEORGE W. TILLSON

Boro Hall, Brooklyn, N. Y.

Chairman of General Committee on Standard Specifications

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SPECIFICATIONS FOR SHEET ASPHALT PAVING.

GENERAL DESCRIPTION.

1. Upon the foundation prepared and laid as elsewhere herein specified, shall be laid the pavement proper. This shall consist of:

1. A binder course ... inches in thickness when compressed.
2. An asphalt wearing surface ... inches in thickness when compressed.

MATERIALS.

2. The materials used must comply with the requirements of these specifications and be suitable for use upon the street or streets to be paved. They shall be mixed in definite proportions by weight, depending upon their character, and the traffic upon the street, and such materials and proportions must be satisfactory to the Engineer.

3. *Methods of Testing*—All tests herein specified must be conducted according to official methods on file in the office of the Engineer. All penetrations at 77 degrees Fahrenheit are expressed in hundredths of a centimeter and are to be taken (except where otherwise specified) with a number two needle acting for five (5) seconds without appreciable friction under a total weight of one hundred (100) grams.

4. *Refined Asphalts*—The refined asphalts admitted under these specifications shall be prepared from a natural mineral bitumen, either solid or liquid, or from combinations thereof, by such methods of refining as will produce a product complying with the requirements hereinafter given.

The preparation and refining of all asphalts admitted under these specifications shall be subject to such inspection at the paving plants and refineries as the Engineer may direct. Every refined asphalt admitted under these specifications, if required by the Engineer, shall be equal in quality to the recognized standard for its particular kind or type of asphalt. If desired, the Contractor may use an asphalt cement prepared at the refinery. To be acceptable this asphalt cement must comply with the foregoing general requirements for refined asphalt, as well as requirements a, b, c, d, and e for asphalt cement.

Asphalt obtained by the refining of natural liquid bitumens shall not be reduced in the refining process to a penetration at 77 degrees F. of less than 30.

All refined asphalts admitted under these specifications must comply with the following requirements:

a. All shipments of refined asphalt of any one kind shall have the batch number plainly marked on each package or container and shall be uniform in consistency and composition and shall not vary from maximum to minimum more than fifteen (15) points in penetration at 77 degrees F.

b. Ninety-eight and one-half ($98\frac{1}{2}$) per cent. of the total bitumen of all refined asphalts shall be soluble in carbon tetrachloride.

c. When made into an asphalt cement by the use of such materials and methods as are described in these specifications, they must produce an asphalt cement complying with all the requirements elsewhere set forth herein for asphalt cements.

5. *Fluxes*—These shall be the residues obtained by the distillation of paraffine, asphaltic or semi-asphaltic petroleum. They shall be of such character that they will combine with the asphalt to be used to form an acceptable and approved asphalt cement complying with the requirements of these specifications. All residuums must pass the following general tests:

a. They must have a penetration greater than three hundred and fifty (350) with a No. 2 needle at 77 degrees F. under fifty (50) grams weight for one second.

b. They shall have a specific gravity at 77 degrees F. between 0.92 and 1.02.

c. When twenty (20) grams of the flux are heated for five (5) hours at 325 degrees F. in a tin box two and one-quarter ($2\frac{1}{4}$) inches in diameter and three-quarters ($\frac{3}{4}$) of an inch deep after the manner officially prescribed, the loss shall not exceed five (5) per cent. by weight and the residue left after such heating shall flow at 77 degrees F.

d. They shall not flash below 350 degrees F. when tested in a closed oil tester.

e. They shall be soluble in carbon tetra-chloride to the extent of not less than ninety-nine (99) per cent.

6. *Binder Stone*—This shall be clean, hard, broken, stone, free from any particles that have been weathered, or are soft. If the stone does not contain the proper amount of material passing the one-

half ($\frac{1}{2}$) inch screen, the deficiency may be made up by the addition of gravel or sand. Ninety-five (95) per cent. of the binder aggregate shall pass a screen having circular openings whose diameter shall be three-quarters ($\frac{3}{4}$) the thickness of the binder course to be laid. The remaining five (5) per cent. shall not exceed in their largest dimension the thickness of the binder course to be laid. The binder aggregate shall be so graded from coarse to fine as to have the following mesh composition (sieves to be used in the order named):

Passing:

10 mesh	15 to 35%	} Total passing	$\frac{1}{2}$ "	35 to 85%
$\frac{1}{2}$ -inch circular opening and retained				
on 10 mesh	20 to 50%			

The above limits as to mesh composition are intended to provide for such permissible variations as may be rendered necessary by the available sources of supply and the character of the work to be done. The mesh composition and character of the stone may be varied, within the limits above specified, at the discretion of the Engineer, depending upon the kind of asphalt used and the traffic conditions upon the street or streets to be paved.

7: *Sand*—The sand shall be hard, clean grained and moderately sharp. On sifting it shall have the following mesh composition, (sieves to be used in the order named):

Passing:

200 mesh	0 to 5%	Total passing
100 mesh and retained on 200 mesh	10 to 25%	80 mesh and
80 mesh and retained on 100 mesh	6 to 20%	retained on
50 mesh and retained on 80 mesh	5 to 40%	200 mesh
40 mesh and retained on 50 mesh	5 to 30%	20 to 40%
30 mesh and retained on 40 mesh	5 to 25%	Total passing
20 mesh and retained on 30 mesh	5 to 15%	10 mesh and
10 mesh and retained on 20 mesh	2 to 10%	retained on
8 mesh and retained on 10 mesh	0 to 5%	40 mesh. .12 to 45%

On very light traffic streets a coarser sand may be used with the approval of the Engineer, but in no case shall a sand be employed that contains less than a total of fifteen (15) per cent. passing an 80 mesh sieve, such total to contain not more than five (5) per cent. (calculated on the original sand) passing a 200-mesh sieve, or a mixture of seventy-five (75) per cent. of sand of the character above specified and twenty-five (25) per cent. of stone screenings passing a one-quarter ($\frac{1}{4}$) inch screen and retained on a 10-mesh screen, may be employed.

The above limits as to mesh composition are intended to provide for such permissible variations as may be rendered necessary by the available sources of supply and the character of the work to be done. The mesh composition and character of the sand may be varied, within the limits above specified, at the discretion of the Engineer, depending upon the kind of asphalt used and the traffic conditions upon the street or streets to be paved.

Filler—This shall be thoroly dry limestone dust or dust from other equally satisfactory stone or Portland cement, the whole of which shall pass a 30-mesh-per-linear-inch screen and at least 66 per cent. of which shall pass 200-mesh-per-linear-inch screen. The surface mixture shall contain from 6 to 20 per cent. of this filler, depending upon the kind of sand and asphalt used and the traffic conditions upon the street or streets to be paved.

8. *Samples*—One (1) pound samples of the refined asphalt, petroleum flux and asphalt cement that the Contractor proposes to use in his work, together with a statement as to the source, character and proportions of the materials composing them, must be handed in with his bid and no contract shall be awarded to any bidder whose samples do not comply in every respect with these specifications. No asphalt other than that specified in his bid shall be used by any Contractor except with the written consent of the Engineer and provided that it complies in all respects with the requirements of these specifications.

In addition to the samples submitted with the bid, other samples taken from and actually representative of the refined asphalt, petroleum flux, sand filler and binder stone to be used upon the street shall be submitted to the Engineer before the use of such materials in the work is permitted. Except at his option, no work on binder or surface shall be commenced within three weeks from the date when such samples were submitted and in no case shall they be used until they have been examined and approved by him. Whenever, during the course of the work, new deliveries of paving materials are received by the Contractor, samples of these shall at once be submitted to the Engineer and their use in the work will not be permitted until they have been examined and approved by him.

ASPHALT CEMENT.

9. *Preparation*—The asphalt cement shall be composed of refined asphalt, or asphalts and flux, where flux is required, of the character elsewhere herein specified and must be of a suitable degree of penetration.

The proper proportions of the refined asphalt, or asphalts, and flux, shall be melted together at a temperature between 275 and 400 degrees F. and thoroly agitated by suitable appliances until they are completely blended into a homogeneous asphalt cement. Thereafter, the asphalt cement must not be heated to a temperature exceeding 350 degrees F. If the asphalt cement contains material that will separate by subsidence while it is in a molten condition, it must be thoroly agitated before drawing from storage and while in use in the supply kettles. Excessive agitation with steam or air which will injure the cement must not be used.

The refined asphalt or asphalts and flux comprising the asphalt cement shall, when required, be weighed separately in the presence of the authorized inspectors or agents of the Engineer.

10. *Requirements*—The asphalt cement shall comply with the following requirements:

- a. It shall be thoroughly homogeneous.
- b. It shall have a penetration at 77 degrees F. of from 30 to 55 for heavy traffic streets and 55 to 85 for light traffic streets depending upon the sand and asphalt used and the local climate conditions.
- c. It shall not flash below 350 degrees F. when tested in a closed oil tester.
- d. When twenty (20) grams of the asphalt cement are heated for five (5) hours at 325 degrees F. in a tin box two and one-quarter ($2\frac{1}{4}$) inches in diameter and three-quarters ($\frac{3}{4}$) of an inch deep, after the manner officially prescribed, the loss shall not exceed five (5) per cent. by weight and the penetration at 77 degrees F. of the residue left after such heating must not be less than one-half the penetration at 77 degrees F. of the original sample before heating.
- e. Either the asphalt cement or its pure bitumen when made into a briquette (Dow mold) shall, at 50 penetration (77) degrees F.), have a ductility of not less than 30 centimeters at 77 degrees F.; the two ends of the briquette to be pulled apart at the uniform rate of 5 centimeters per minute.

When the asphalt cement as used has a penetration other than 50 at 77 degrees F., an increased ductility of 2 centimeters will be required for every five points in penetration above 50 penetration and a corresponding allowance will be made below 50 penetration.

BINDER.

11. *Preparation*—The binder shall be composed of stone, or stone and sand, and asphalt cement of the character elsewhere herein

specified and mixed in proper proportions. The stone, or stone and sand, and the asphalt cement shall be heated separately to such a temperature as will give, after mixing, a binder of the proper temperature for the materials employed. The stone when used must be at a temperature between 225 and 350 degrees F. The asphalt cement and stone shall be thoroly mixed by machinery until a homogeneous mixture is produced in which all the articles are thoroly coated with asphalt cement.

12. *Laying*—The binder mixture prepared in the manner above described shall be brought to the work in wagons covered with canvas or other suitable material and upon reaching the street shall have a temperature between 200 degrees F. and 325 degrees F. The temperature of the binder mixture within these limits shall be regulated according to the temperature of the atmosphere and the working of the binder. On reaching the street it shall at once be dumped on the concrete and then be deposited roughly in place by means of hot shovels, after which it shall be uniformly spread by means of hot iron rakes and then at once be thoroughly compacted by tamping or rolling. The thickness of the finished binder shall average . . . inches and not more than forty (40) per cent. variation from the average thickness specified will be permitted at any one spot. The upper surface of the finished binder shall be parallel to the established grade for the finished pavement. The surface after compression shall show at no place an excess of asphalt cement and any spot showing such excess shall be cut out and replaced with other material. All binder that shows lack of bond or that is in any way defective or which may become broken up before it is covered with wearing surface must be taken up and removed from the street and replaced by good material properly made and laid in accordance with these specifications, at the expense of the Contractor. No more binder shall be laid at any one time than can be covered by one day's run of the paving plant on surface mixture. Binder when laid shall be followed and covered with wearing surface as soon as is practicable in order to effect the most thoro bond between the binder and the wearing course. The binder course shall be kept as clean and as free from traffic as is possible under working conditions. If necessary, it must be swept off immediately before laying the wearing surface on it.

No binder shall be laid when in the opinion of the Engineer the weather conditions are unsuitable or unless the concrete on which it

is to be laid is, even though damp, free from pools of water and has set a sufficient length of time.

13. *Requirements*—The finished binder must contain four (4) to seven (7) per cent. of bitumen soluble in cold carbon disulphide, from fifteen (15) to thirty-five (35) per cent. of material passing a 10-mesh screen, and from twenty (20) to fifty (50) per cent. of material passing a one-half ($\frac{1}{2}$) inch screen, the percentage of bitumen to be regulated in accordance with the mesh composition and character of the mineral aggregate of the binder and the percentage of material passing a 10-mesh screen to be regulated in accordance with the traffic conditions upon the street or streets to be paved.

WEARING SURFACE.

14. *Preparation*—The wearing surface shall be composed of sand, filler and asphalt cement of the character elsewhere herein specified and mixed in proper and definite proportions by weight. The sand and the asphalt cement shall be heated separately to such a temperature as will give, after mixing, a surface mixture of the proper temperature for the materials employed. The sand when used must be at a temperature between 275 and 400 degrees F. The asphalt cement when used must be at a temperature between 250 degrees F. and 350 degrees F. The various ingredients shall be brought together and mixed for at least one minute in a suitable apparatus until a homogeneous mixture is produced in which all the particles are thoroughly coated with asphalt cement. The weights of all materials entering into the composition of the wearing surface shall be verified in the presence of inspectors as often as may be required and the Engineer or his representatives shall have access to all parts of the plant at any time.

15. *Laying*—The surface mixture prepared in the manner above described shall be brought to the work in wagons covered with canvas or other suitable material and upon reaching the street shall have a temperature between 230 degrees F. and 350 degrees F. The temperature of the surface mixture within these limits shall be regulated according to the temperature of the atmosphere and the working of the mixture and the character of the materials employed. On reaching the street it shall at once be dumped on a spot outside of the space on which it is to be spread. It shall then be deposited roughly in place by means of hot shovels, after which it shall be uniformly spread by means of hot iron rakes in such a manner that after having

received its final compression by rolling, the finished pavement shall conform to the established grade. The thickness of the finished surface mixture shall average ... inches. Not more than a ten (10) per cent. variation from the average thickness specified will be permitted in any one spot. Before the surface mixture is placed, all contact surfaces of curbs, manholes, etc., must be well painted with hot asphalt cement. After raking, the surface mixture shall at once be compressed by rolling or tamping, after which a small amount of cement shall be swept over it and it shall then be thoroly compressed by a steam roller weighing not less than two hundred (200) pounds to the inch width of tread, the rolling being carried on continuously at the rate of not more than two hundred (200) square yards per hour per roller, until a compression is obtained which is satisfactory to the Engineer. Such portions of the completed pavement as are defective in finish, compression or composition, or that do not comply in all respects with the requirements of these specifications, shall be taken up, removed and replaced with suitable material, properly made and laid in accordance with these specifications at the expense of the Contractor. Whenever so ordered by the Engineer, a space of twelve (12) inches next to the curb shall be coated with hot asphalt cement, which shall be ironed into the pavement with hot smoothing irons.

No wearing surface shall be laid when in the opinion of the Engineer the weather conditions are unsuitable or unless the binder on which it is to be placed is dry. Excessive use of water on the steam roller when compressing the pavement will not be permitted. The finished pavement must be well protected from all traffic by suitable barricades until it is in proper condition for use.

16. *Requirements*—The finished pavement shall show upon analysis a mesh composition and bitumen contents within the following limits (sieves to be used in the order named):

Bitumen	9.5 to 13.5%	} Total passing 200, 100 and 80 mesh.
Passing 200 mesh..	Not less than 10%	
Passing 80 mesh	10 to 35%	} Not less than.....25%
Passing 50 mesh	4 to 35%	
Passing 40 mesh	4 to 25%	} Total passing 50 and 40
Passing 30 mesh	4 to 20%	
Passing 20 mesh	4 to 12%	} Total passing mesh.....15 to 50%
Passing 10 mesh	2 to 8%	
Passing 8 mesh	0 to 5%	
		} 30, 20 and 10 mesh.....10 to 35%

The minimum amount of bitumen shall be used only in mixtures containing the minimum total passing the 80 mesh. The percentage

of bitumen must be increased above the minimum as the total passing the 80-mesh increases. On streets of very light traffic, when the Engineer has approved the use of a coarser sand or mixture than that specified for general use, the surface mixture must contain not less than six (6) per cent. of mineral matter passing a 200-mesh sieve and not less than a combined total of eighteen (18) per cent. passing the 200, 100 and 80 mesh sieves. The maximum amount of 200, 100, and 80 mesh material will be regulated according to the kind of sand and asphalt used and the traffic upon the street on which the pavement is to be laid, subject to the maximum requirements elsewhere herein specified under sand and filler.

The above limits as to mesh composition and per cent. of bitumen are intended to provide for such permissible variations as may be rendered necessary by the raw materials used and by the character of the work to be done. The composition of the wearing surface may be varied within the limits above specified at the discretion of the Engineer, depending upon the kind of sand, filler and asphalt used and the traffic conditions upon the street or streets to be paved.

CONDITION AT EXPIRATION OF GUARANTEE.

17. In addition to the proper maintenance of the pavement during the period of guarantee, the Contractor shall, at his own expense, just before the expiration of the guarantee period, make such repairs as may be necessary to produce a pavement which shall:

a. Have a contour substantially conforming to that of the pavement as first laid and free from depressions of any kind exceeding one-half ($\frac{1}{2}$) of an inch in depth as measured between any two points three (3) feet apart on a line conforming substantially to the original contour of the street.

b. Be free from cracks or depressions showing disintegration of the surface mixture.

c. Contain no disintegrated surface mixture.

d. Not have been reduced in thickness more than three-eighths of an inch in any part.

e. Have a foundation free from such cracks or defects as will cause disintegration or settling of the pavement or impair its usefulness as a roadway.

REPAIRING.

18. Repairs, except as provided for below, shall in all cases be made by cutting out the defective binder and wearing surface down

to the concrete and replacing them by new and freshly prepared binder and wearing surface made and laid in strict accordance with these specifications.

Whenever any defects are caused by the failure of the foundation, the pavement, including such foundation, shall be taken up and relaid with freshly prepared material made and laid in strict accordance with these specifications.

In all cases the surface of the finished repair shall be at the grade of the adjoining pavement and in accordance with the contour of the street.

The surface heater method of repairing may be used only in those cases where the repairs are not rendered necessary by:

- a. Failure of concrete.
- b. Failure of the binder.
- c. Failure caused by the disintegration of the lower portion of the wearing surface.

Whenever the surface heater method is employed, all defective surface shall be removed before replacing it with new material. In all cases the old surface shall be removed to a depth of not less than one-quarter inch and the new surface must, when compressed, be not less than one-half inch in thickness. The heat shall be applied in such a manner as not to injure the remaining pavement. All burnt and loose material shall at once be completely removed and, while the remaining portion of the old pavement is still warm, shall be replaced by new and freshly prepared wearing surface made and laid in strict accordance with these specifications.

19. NOTE TO ENGINEERS—Filler—As Portland cement is more expensive than lime dust, the specification should distinctly state which kind of filler is desired.

Binder—The following clause has been suggested as being descriptive of the practice in some cities. The committee, however, does not feel like recommending it in a general specification. If this clause is incorporated in the specifications it should be clearly stated whether or not the practice described therein will be permitted by the City Engineer.

With the permission of the City Engineer not to exceed twenty (20) per cent. of crushed old asphalt surface mixture of suitable character may be used in combination with the binder stone, provided that such mixture produces a binder complying in all respects with the requirements of these specifications.

METHODS FOR TESTING AND SAMPLING.

The following methods are recommended as being sufficiently accurate for general use. In cases of dispute the standard methods adopted by the American Society for Testing Materials must be employed.

PENETRATION TEST.

20. Penetrations shall be taken by means of a penetrometer, which shall be so constructed as to correctly register in one-hundredths of a centimeter the depth to which a Robert's Sharps No. 2 needle will penetrate the sample under examination under a given load without appreciable retarding friction for a given time period.

For penetrations at 77 degrees F. the time period shall be five (5) seconds and the total weight operating on the needle shall be one hundred (100) grams except in the case of flux where the time period is one (1) second and the total weight fifty (50) grams.

The samples to be tested should preferably be in circular tin boxes about two and one-quarter ($2\frac{1}{4}$) inches in diameter and about three-quarters ($\frac{3}{4}$) of an inch deep (2 ounce Gill style can, obtainable from the American Can Company). Where very soft materials are to be tested or penetrations are to be taken at 100 degrees F. or 115 degrees F., a tin not less than two (2) inches deep and having the same diameter specified above should be used to prevent the needle from striking the bottom of the tin before it has penetrated the sample to the full depth.

All samples shall be melted at a temperature just high enough to render them liquid (250 to 300 degrees F.) and should then be thoroly stirred until homogeneous and free from air bubbles. After cooling sufficiently in the air at laboratory temperature they must be immersed for at least thirty (30) minutes in water maintained at the temperature at which the test is to be made (77 degrees F.). During testing the sample shall be accurately maintained at the temperature specified.

The average of from three (3) to five (5) tests, which must not differ more than five (5) points (five-hundredths (0.05) of a centimeter) between maximum and minimum, shall be taken as the penetration of the sample, the needle being wiped off with a dry cloth after every determination.

Remarks—This test measures the consistency of the material under examination. The limits of accuracy of this test may be considered as being within five (5) per cent. of the reading obtained (above or below).

DUCTILITY TEST.

21 This test is usually first made on the asphalt cement itself. If this fails to show the required ductility, the pure bitumen must be extracted and tested. The proper methods for obtaining the pure bitumen vary with the asphalt being examined and are too lengthy for description here. (See proceedings of American Society for Testing Materials, Vol. 9, pages 594-9.)

Preparation of Briquette—The molding of the briquette may be done as follows:

The mold should be placed upon a brass plate. To prevent the asphalt from adhering to the plate and the inner side of the two removable pieces of the mold, they should be well amalgamated. The different pieces of the mold should be held together in a clamp or by means of an India rubber band. The material to be tested is poured into the mold while in a molten state, a slight excess being added to allow for shrinkage on cooling. After the briquette is nearly cool, it is smoothed off level by means of a heated palette knife. When cooled, the clamp is taken off and the two side pieces removed, leaving the briquette of asphalt firmly attached to the two ends of the mold, which thus serve as clips. The briquette should be immersed in water maintained at the required temperature for at least thirty (30) minutes or until the whole mass of bitumen is at 77 degrees F. It is then pulled apart at the required rate of speed in a suitable machine, the briquette being entirely immersed in water maintained at 77 degrees F. during the entire operation of pulling. Any pieces of dirt, wood, or extraneous matter in the briquette may cause the fracture of the fine thread before the true maximum ductility of the material under examination has been reached. Great care should be observed, therefore, to avoid the presence of such foreign matter in the bitumen when it is poured into the mold. The average of at least two tests shall be recorded as the ductility of the sample under examination. These tests must not differ more than twenty (20) per cent. from their average.

Remarks—This test measures approximately the cementing value of a bitumen, but is not necessarily a measure of the relative cement-

ing value of different bituminous materials or the same bituminous material at different penetrations. The limits of accuracy of this test may be considered as being within twenty (20) per cent. of the reading obtained (above or below).

DETERMINATION OF TOTAL BITUMEN IN REFINED ASPHALTS AND ASPHALT CEMENTS.

22. One to two grams of the sample shall be weighed into a tared 200 c. c. wide-mouth Erlenmeyer flask and covered with 100 c. c. of chemically pure carbon disulphide. Agitate until all lumps disappear and nothing adheres to the bottom of the flask. Cork and allow to stand fifteen (15) minutes. Filter off on a Gooch crucible with asbestos felt or a weighed filter paper and wash until the washings come thru practically colorless. Dry the flask and filter at 250 degrees F. Evaporate the filtrate containing the bitumen, burn to an ash and add to the residue on the filter.

Remarks—The limits of accuracy of this test as applied to bitumens containing considerable proportions of non-bituminous matter may be considered as being within one-half per cent. above or below the result obtained. In practically pure bitumens one-quarter ($\frac{1}{4}$) per cent. above or below is the ordinary limit of accuracy.

DETERMINATION OF BITUMEN SOLUBLE IN CARBON TETRACHLORIDE.

23. One gram of the sample shall be weighed into a tared 200 c. c. wide mouth Erlenmeyer flask and covered with 100 c. c. of chemically pure carbon tetra-chloride. Agitate until all lumps disappear and nothing adheres to the bottom of the flask. Cork and allow to stand eighteen (18) hours in the dark. Filter off on a Gooch crucible with asbestos felt or a weighed filter paper and wash until the washings come thru practically colorless using not less than 100 c. c. of fresh solvent. Dry the filter at 250 degrees F.

Remarks—The amount of bitumen insoluble in carbon tetra-chloride is indicative of whether or not decomposition has been produced by improper heat treatment. The limits of accuracy of this test may be considered as being within one-half ($\frac{1}{2}$) per cent. above or below the result obtained.

VOLATILIZATION TEST.

24. Twenty (20) grams of the sample shall be placed in a weighed tin box two and one-quarter inches in diameter and three-quarters of an inch high (two ounce Gill style can, obtainable from the American Can Company) and heated five (5) hours at 325 degrees F. The heating shall be done in a ventilated oven which shall have reached the temperature specified before the introduction of the samples and which is maintained within two (2) degrees of that temperature thruout the test. The tin can should be insulated by a sheet of asbestos or other material from direct metallic contact with the sides or walls of the oven. The bulb of the thermometer should be immersed in a control bath immediately alongside of the sample being tested, the container and the method of insulation being the same in both cases.

Remarks—This test indicates the extent to which bitumens in the course of time lose their more volatile hydro-carbon constituents and the hardening resulting from volatilization and chemical change. It may be considered as an accelerated exposure test. The limits of accuracy of this test cannot be definitely stated owing to the widely varying results obtained by the use of different types of ovens and failure to carefully observe all the conditions prescribed. When carefully conducted according to the above directions a test showing six (6) per cent. loss should be considered as passing a specification calling for not over five (5) per cent. loss.

FLASH TEST.

25. Flash test shall be made in a circular tin can about two and one-quarter ($2\frac{1}{4}$) inches in diameter and about one and three-eighths ($1\frac{3}{8}$) inches deep, (3 ounce Gill style, American Can Company), provided with a suitable transparent cover of mica, or glass, etc. This cover shall be provided with two apertures for the insertion of the thermometer and test flame. The aperture for the thermometer shall be three-eighths ($\frac{3}{8}$) of an inch in diameter and shall be centrally located. The aperture for the test flame shall be triangular in shape measuring one-half ($\frac{1}{2}$) inch on the base and three quarters of an inch in height. The base shall coincide with the rim of the can. A thermometer approximately fifteen (15) inches long, graduated in single degrees shall have its bulb completely immersed in the material being tested. It shall not touch the bottom of the can and shall be suspended in the proper position.

The can shall be filled with the material to be tested so as to leave a one-half ($\frac{1}{2}$) inch vapor space when melted. The material shall be heated at the rate of ten degrees F. a minute and the test flame applied every five degrees F. after a temperature of 300 degrees F. has been reached. No correction for emergent stem shall be made. The test flame shall be one-eighth ($\frac{1}{8}$) of an inch long and shall be dipped in just below the surface of the cover and then immediately withdrawn.

Remarks—This test indicates the temperature at which inflammable vapors are given off in an enclosed space. It supplements the volatilization test and guards against the use of a material containing too large an amount of volatile hydrocarbons. The limit of accuracy of this test may be considered as being five (5) degrees above or below the reading obtained.

SPECIFIC GRAVITY TEST.

26. a. Fluid Materials:

The specific gravity of fluid materials shall be taken in the usual way in a picnometer at 77 degrees F.

b. Viscous Fluid and Semi-Solid Materials:

The specific gravity of these materials shall be taken in a cylindrical weighing bottle picnometer as given on page 10, bulletin No. 38 of the Office of Public Roads.

c. Hard Solid Materials:

The specific gravity of hard, solid materials shall be taken by the displacement method.

DETERMINATION OF BITUMEN CONTENTS AND MESH COMPOSITION OF BINDER.

27. Weigh out from 350 to 500 grams of the binder and extract the bitumen from it in a centrifugal extractor or suitable continuous hot extractor using chemically pure carbon disulphide as a solvent for the bitumen. Follow the same general method for the drying and sifting of the mineral aggregate as described in the method for analyzing surface mixtures. The sieves to be used are as follows:

1½-inch, 1-inch, ¾-inch and ½-inch circular openings, and 10-mesh.

Remarks—The limits of accuracy of this test are as follows:

For bitumen contents, three-tenths (0.3) per cent. above or below the result obtained. For mesh composition, ten (10) per cent. of the result obtained (above or below).

DETERMINATION OF BITUMEN CONTENTS AND MESH COMPOSITION OF SURFACE MIXTURES.

28. The sample of surface mixture should be heated to about 300 degrees F. until soft and ten to twenty grams of it weighed on to a tared S. & S. filter paper No. 595, 11 cms. in diameter. The filter paper and contents should be placed in a funnel and washed with chemically pure carbon disulphide until the washings run thru practically colorless. Dry the filter paper and residue at 250 degrees F. for one-half ($\frac{1}{2}$) hour. Open the filter paper carefully and remove the mineral aggregate. Scrape off the dust adhering to the paper as thoroly as possible with a blunt palette knife and add it to the mineral aggregate. Evaporate the filtrate containing the bitumen, burn the bitumen, add the filter paper to it and burn to an ash. Add the ash to the mineral aggregate previously removed from the filter paper and weigh. The difference between the weight of surface mixture originally taken and the combined weight of the ash and residue is considered as the weight of bitumen in the sample. The combined ash and residue is then sifted through the following sieves (in the order named) and the percentages of the various sized particles calculated:

200, 100, 80, 50, 40, 30, 20, 10 and 8.

Sifting shall be continued on each sieve until less than one (1) per cent. passes thru the sieve during the last minute of sifting.

If desired, the surface mixture may be extracted in a centrifuge or in any suitable form of extractor with hot chemically pure carbon disulphide and the combined ash from the extracted bitumen and the mineral aggregate sifted as above.

Remarks—The limits of accuracy of this test are as follows:

For bitumen contents, three-tenths (0.3) per cent. above or below the result obtained. For mesh composition, ten (10) per cent. of the result obtained (above or below).

SAMPLES.

29. Samples should be put in clean, dry containers, preferably tin boxes or cans. The following amounts of the different materials are required for test:

Binder stone	5 pounds
Filler	½ pound
Sand	1 pound
Refined asphalt	1 pound
Asphalt cement	1 pound
Flux	1 pound

Method of Sampling—Extreme care should be taken in every case to obtain a sample which is truly representative of the material to be examined. These samples are for the use of the testing laboratory only and should not be used for testing at the plant before submitting them to the laboratory. The particular precautions to be observed in each case are given below:

Binder Stone—A sufficient number of five-pound samples to be taken from different parts of the pile. These should be thoroughly mixed together and reduced by quartering to the desired size.

Filler—A sample should be taken from several bags and mixed:

Sand—Samples should be taken from the interior of the pile where the sand is damp. A sufficient number of one pound samples to be taken from different parts of the pile. These should be thoroughly mixed together and reduced by quartering to the desired size.

REFINED ASPHALT AND ASPHALT CEMENT.

30. In barrels:

At least one sample should be taken from each batch. It should be taken at sufficient depth below the surface to insure obtaining representative material free from all dirt or other extraneous matter, and at a point not less than four (4) inches distant from the top and sides of the barrel.

In tank cars:

The contents of the tank should be heated until completely liquid thruout. It should then be agitated and thoroly mixed by means of air or steam, after which the sample shall be taken from the dome in such a manner as to obtain the asphalt from a point at least three (3) feet below the surface.

In kettles:

The contents of the kettles must be completely liquid and thoroly agitated previous to and during sampling. The sample may be taken from the pipe thru which the material is delivered to the mixer or by means of a clean dipper.

31. *Flux*—The directions given for sampling refined asphalt and asphalt cement apply to this material except that under ordinary conditions it is not necessary to agitate the contents of the tank car.

32. *Surface and Binder Mixtures*—Samples should preferably be taken on the street after the mixture has been shoveled and raked. Samples taken from the plant shall be obtained from the wagons, special care being observed to avoid material from the top of the load or which appears to vary from the average. Samples should be pressed between a sheet of paper and trimmed while hot to a convenient size.

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